Remarks

Upon entry of the Amendment, Claims 1-30 are pending. Claims 1,11, 17, 19 and 24 have been amended. As such, it is respectfully submitted that the application is in condition of allowance.

Claim Rejections- 35 USC § 103

Claims 1-7, 9, 11, 12, 15, 17, 19 and 20-23[1] have been rejected under 35 USC § 103 as being unpatentable over Lin US Patent No. 6,069,061 ("the Lin patent") and Taniguchi US Patent No. 6,690,050 ("the Taniguchi patent").The Lin patent was cited as disclosing a method of forming a gate electrode. As the Examiner correctly points out, The Lin patent does not disclose annealing. The Taniguchi patent was cited to disclose that annealing at 1000° C for 10 minutes is used to activate dopant materials in a semiconductor during the manufacturing process.

The Lin patent discloses formation of a gate stack by deposition of a first gate layer of 800-1200 Angstroms; doping the first gate layer, forming a diffusion stop, such as an oxide layer, on the first doped layer; forming a second gate layer of 500-900 Angstrom on top of the diffusion stop; and doping the second gate layer. The purpose of the two step formation of the gate electrode is to prevent diffusion of the dopant into the dielectric layer and the substrate underneath the gate electrode ("The method prevents the heavy ions from passing through the polysilicon gate and the gate oxide layer into the substrate…" Lin patent, Col. 2, lines 19-21.)

While the Lin patent addresses the issue of diffusion of the dopant into the gate oxide and the substrate, it does not even mention the problem of depletion of the gate stack, adjacent the gate electrode/ gate oxide interface. More particularly, certain gate materials, such as polysilicon,

[1] Paragraph 1 of the Detailed Action states Claims 1-7, 9, 12, 15 and 20-23 are rejected. However, paragraph 1 also mentions claims 11, 17 and 19. Therefore, the Applicant will treat the rejection as a rejection of Claims 1-7, 9, 11, 12, 15, 17, 19 and 20-23.

have rwelatively non-uniform diffusion characteristics. As such there is relatively fast diffusion down to the grain boundaries in the polysilicon causing some of the dopant to diffuse to the interface while most of the dopant needs to diffuse. As is known in the art, heat treatment is used to force diffusion of the dopant. However, such heat treatment can also cause penetration of the gate oxide layer, which is undesirable.

The present invention solves both the diffusion problem and the gate depletion problem. The gate depletion problem is solved by depositing a relatively thin first gate electrode layer in which the thickness is selected to minimize gate depletion adjacent the interface between the first gate layer and the gate oxide. The first gate layer is then doped, and, unlike the Lin patent, the second gate layer is formed directly on the doped first layer. Since gate depletion is normally prevalent adjacent the gate electrode/gate oxide interface, normally heat treatment is used to mitigate the depletion. However, the heat treatment increases the risk that the dopant will penetrate the gate oxide. The present invention provides a relatively thin first electrode layer in which the thickness is selected to minimize gate depletion adjacent the gate oxide interface. Doping the first gate electrode layer, for example, with an ultrashallow implant, minimizes the gate depletion issue adjacent the gate oxide interface. As such, the heat treatment temperature profile is selected to provide relatively uniform diffusion without consideration of gate depletion at the gate oxide interface. As such spike annealing can be used to activate the dopant using the process in accordance with the present invention.

Based on the above, it is respectfully submitted that the present invention is an improvement over the process disclosed in the Lin patent for several reasons. First, the present invention does not require a diffusion stop, such as a oxide layer, between gate electrode layers, making the present invention a simpler process. As such, in this regard the Lin patent actually teaches away from the invention. Second, the present invention solves the problem of gate depletion adjacent

the gate oxide interface. This problem is not even recognized by the Lin patent. For all of the above reasons, the Examiner is respectfully requested to reconsider and withdraw this rejection.

Claims 8, 10 and 18 have been rejected under 35 USC § 103 as being unpatentable over the Lin and Taniguchi patents and further in view of Goto US Patent No. 6,013,332 ("the Goto patent"). Claims 8, 10 and 18 are all dependent claims and recite, in combination, depositing a relatively thin first gate layer, the thickness of which is selected to minimize gate depletion adjacent the interface between the gate oxide and the gate electrode. These claims also recite that the second gate layer is deposited directly on said first gate layer. As mentioned, these features are not disclosed or suggested by either the Lin patent or the Taniguchi patents. The Goto patent was cited for using decaborane as a dopant source. The Goto patent does not otherwise disclose or suggest the features mentioned above. For these reasons and the above reasons, the Examiner is respectfully requested to reconsider and withdraw the rejection of these claims.

Claims 13 and 16 have been rejected under 35 USC § 103 as being unpatentable over the Lin and Taniguchi patents and further in view of Mannino, Nuclear Instruments and Methods in Physics Research B186 (2002), pages 246-255 ("the Mannino reference") Claims 13 and 16 are both dependent claims and recite, in combination, depositing a relatively thin first gate layer, the thickness of which is selected to minimize gate depletion adjacent the interface between the gate oxide and the gate electrode. These claims also recite that the second gate layer is deposited directly on said first gate layer. As mentioned, these features are not disclosed or suggested by either the Lin patent or the Taniguchi patents. The Mannino was cited for disclosing dopant clusters as a dopant source. The Mannino reference does not otherwise disclose or suggest the features mentioned above. For these reasons and the above reasons, the Examiner is respectfully requested to reconsider and withdraw the rejection of these claims.

Claim 14 been rejected under 35 USC § 103 as being unpatentable over the Lin and Taniguchi patents and further in view of Gardner US Patent No. 5,885,877 ("the Gardner patent"). Claim 8, is a dependent claim and recites, in combination, depositing a relatively thin first gate layer, the thickness of which is selected to minimize gate depletion adjacent the interface between the gate oxide and the gate electrode. These claims also recite that the second gate layer is deposited directly on said first gate layer. As mentioned, these features are not disclosed or suggested by either the Lin patent or the Taniguchi patents. The Gardner patent was cited for using a nitrogen molecule implant. The Gardner patent does not otherwise disclose or suggest the features mentioned above. For these reasons and the above reasons, the Examiner is respectfully requested to reconsider and withdraw the rejection of this claim.

Claim 27 been rejected under 35 USC § 103 as being unpatentable over Lee US Patent No. 5,773,337 ("the Lee patent") and further in view of the Mannino reference. Claim 27, is a dependent claim and recites, in combination, that the implant energy is selected such that the dopant is contained within the dielectric layer. As mentioned below in connection with the rejection under 35 USC § 102. This feature is not disclosed or suggested by either the Lee patent or the Mannino reference. The Mannino reference was cited for disclosing the use of a boron cluster in the formation of ultrashallow junctions. . The Mannino reference does not otherwise disclose or suggest the features mentioned above. For these reasons and the reasons below, the Examiner is respectfully requested to reconsider and withdraw the rejection of this claim.

Claim 28 been rejected under 35 USC § 103 as being unpatentable over the Lee patent and further in view of Marinskiy, Materials Research Society Symposium, Vol. 669, pages J2.5.1-J2.5.6 ("the Marinskiy reference") . Claim 28, is a dependent claim and recites, in combination, that the implant energy is selected such that the dopant is contained within the dielectric layer. As mentioned below in connection with the rejection under 35 USC § 102. This feature is not disclosed or suggested by either the Lee patent or the Marinskiy reference. The Marinskiy

reference was cited for disclosing the passivation of boron by hydrogen in silicon IC fabrication. . The Marinskiy reference does not otherwise disclose or suggest the features mentioned above. For these reasons and the reasons below, the Examiner is respectfully requested to reconsider and withdraw the rejection of this claim.

Claim 30 been rejected under 35 USC § 103 as being unpatentable over the Lee patent and further in view of Muller US Patent No. 6,693,051 ("the Muller patent"). Claim 30, is a dependent claim and recites, in combination, that the implant energy is selected such that the dopant is contained within the dielectric layer. As mentioned below in connection with the rejection under 35 USC § 102, this feature is not disclosed or suggested by either the Lee patent or the Muller patent. The Muller patent was cited for disclosing the use of silicon oxide as a gate dielectric layer in a gate electrode. . The Muller patent does not otherwise disclose or suggest the feature mentioned above. For these reasons and the above reasons, the Examiner is respectfully requested to reconsider and withdraw the rejection of this claim.

Claim Rejections- 35 USC § 102

Claims 24, 25, 26 and 29 have been rejected under 35 USC § 102 (e) as being anticipated by Lee US Patent No. 5,773,337. In order for there to be anticipation, each and every element of the claims must be found in a single reference. It is respectfully submitted that these claims contain elements not disclosed or suggested by the Lee patent. For example, these claims now recite that the implant energy be selected such that the dopant is contained within the dielectric layer; The Lee patent does not disclose or suggest such a feature. In fact, the Lee patent uses an oxide only to prevent metal impurities from penetrating into the substrate ("In order to prevent the metal impurities, which might be implanted together with dopants during the ion implantation, from penetrating into the substrate, the above ion implantation processes are carried out through a thermal oxide which has grown to a thickness of 50-100 Angstrom in a dry manner." Lee patent,

Col. 2, line 66 to Col. 3, line 4). Moreover, it is respectfully submitted that the dielectric layer (5) referred to by the Examiner in Paragraph 5 of the Detailed Action does not appear to be doped as illustrated in Fig. 2A. In particular , the references to the Lee patent, Col.2, lines 48-65 refer to the doping of the p-well region 7; the p^+ source/drain region 10; and the n^+ source/drain region 9, as illustrated in Fig. 2A. As shown, these regions are adjacent to the dielectric layer (5) . There is no disclosure in the Lee patent that suggests that the doping of the aforementioned regions is initially contained in the dielectric layer and diffused into the regions in the substrate mentioned above by heat treatment. Accordingly, for all of the above reasons, it is respectfully submitted that there can be no anticipation. Thus, the Examiner is respectfully requested to reconsider and withdraw this rejection.

Respectfully submitted,

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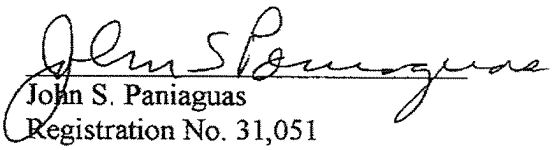
By: 

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